Landing Site Thermal Minima for Rover Lifetime Concerns

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Effect of Low Night Temperatures

- Rovers use battery power to maintain internal thermal state at night
- Batteries are recharged by solar energy
- Cold nighttime conditions can drain batteries to the extent daytime operations must be constrained
- Total solar input is limited, and thus lifetime of rovers can be limited by nighttime ambient conditions
- Coldest minima occur at the end of the nominal mission

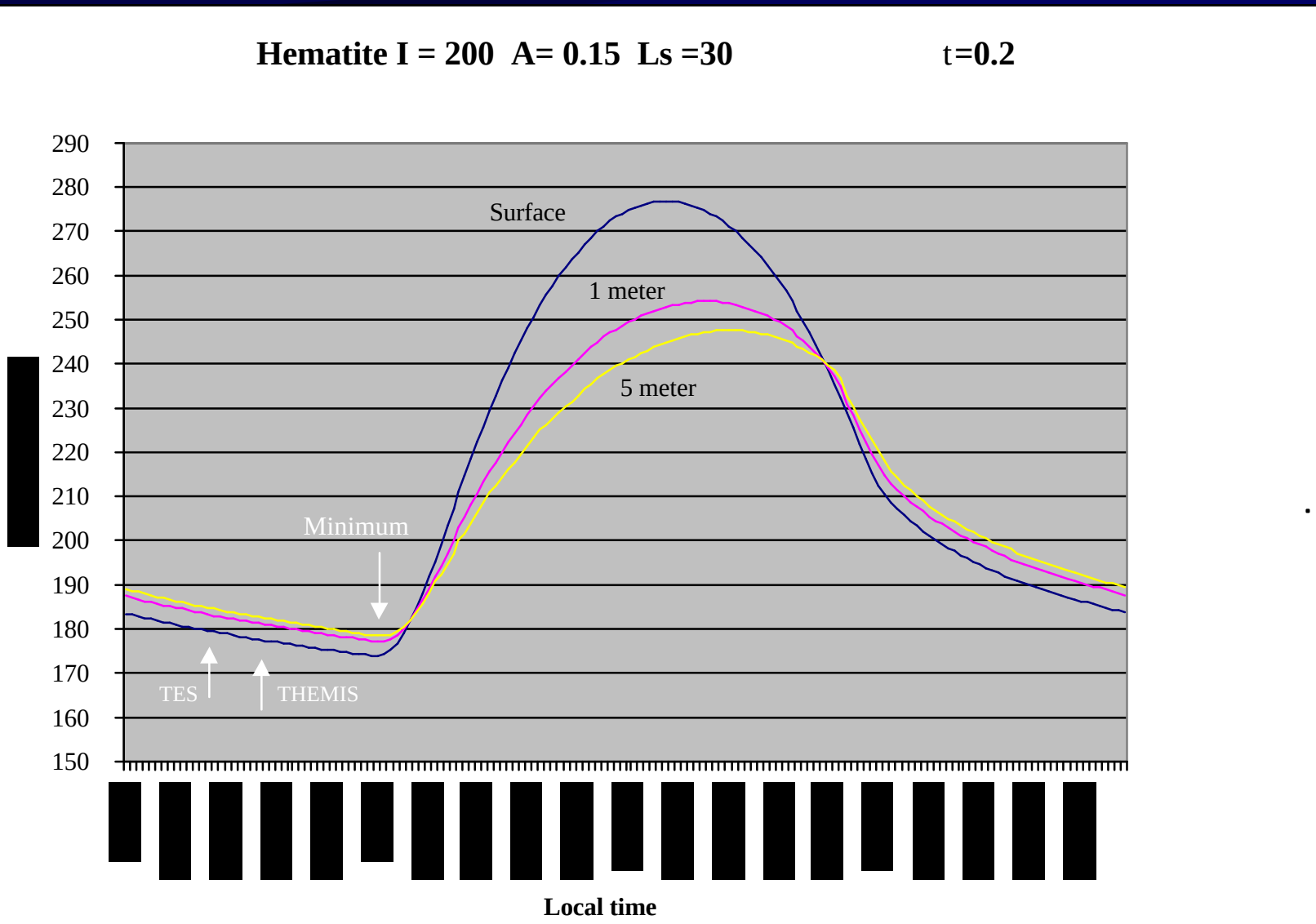
1-m Air Temperatures

- Worst case cold conditions occur predawn
- Surface thermal inertia is the strongest influence
- TES, THEMIS measure predawn surface temperatures that are most sensitive to thermal inertia variation
- Other relevant parameters:
  - Dust optical depth (clear implies cold)
  - Latitude
  - Ls
  - Albedo
  - Elevation (surface pressure)

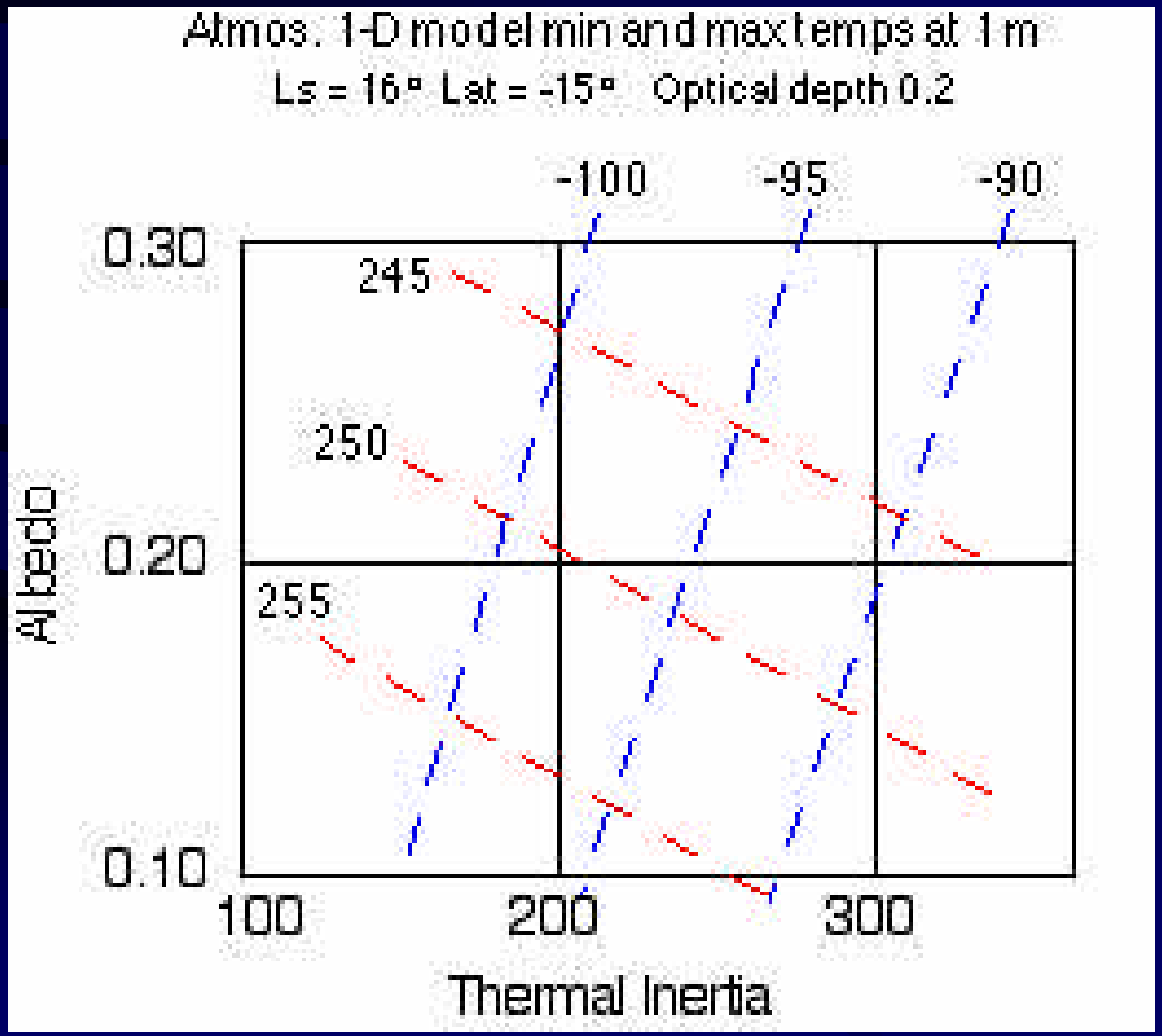
Process

- Albedo and inertia maps supplied by TES team
- Run 1-D model developed by J. Murphy (NMSU) to treat Viking and Pathfinder near-surface air measurements
- Model outputs surface and air temps as function of time of day, opacity, latitude, Ls, albedo, inertia
- Produce A/I plot for each landing site
- Minimum air temp can be expressed as contours in A/I space for a given opacity and Ls
- Map the points falling below -97 C
- Produce histograms using ellipse probability density distribution

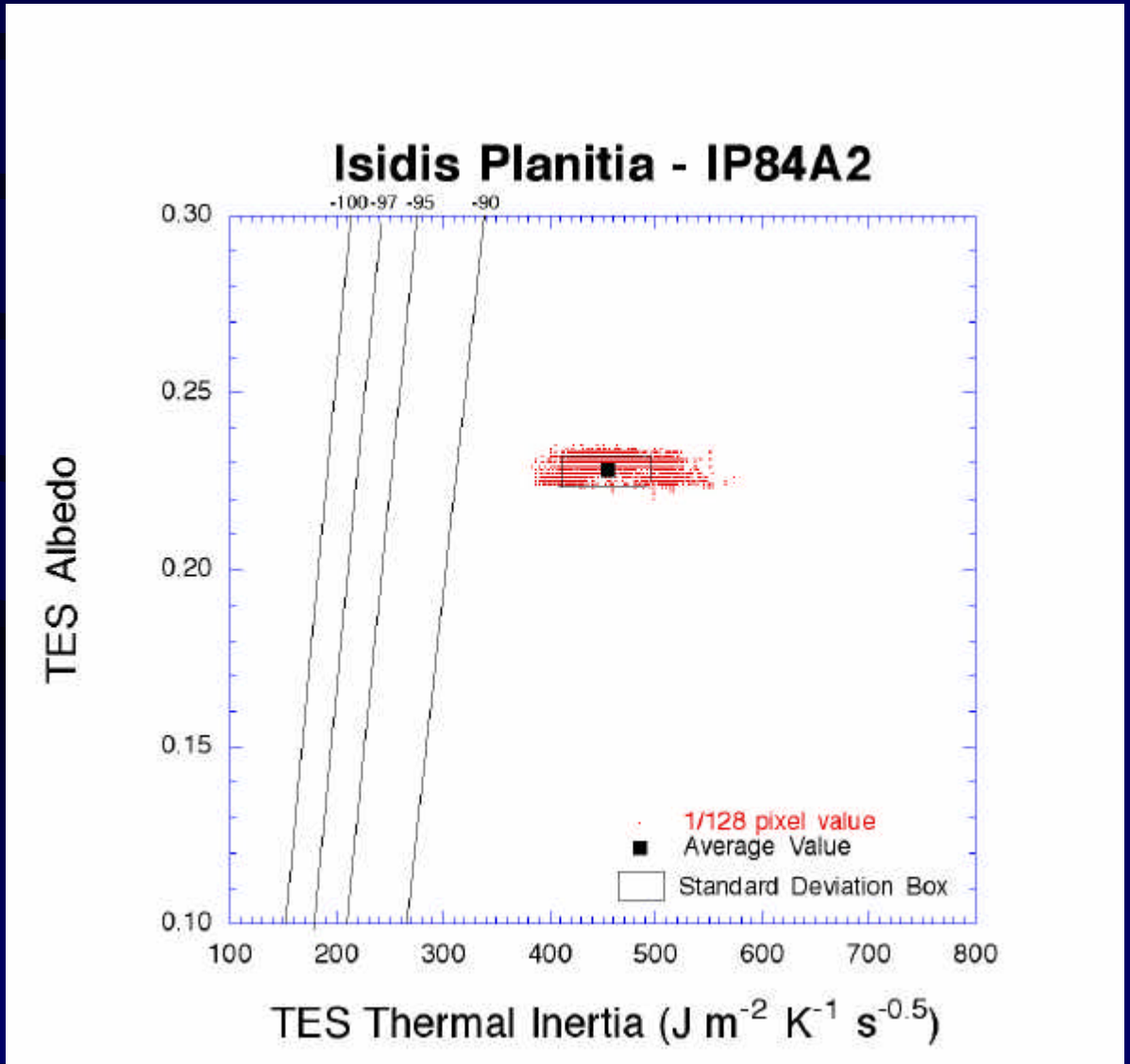
Typical Near-surface Thermal Behavior



Thermal Contours in Albedo/Inertia Space



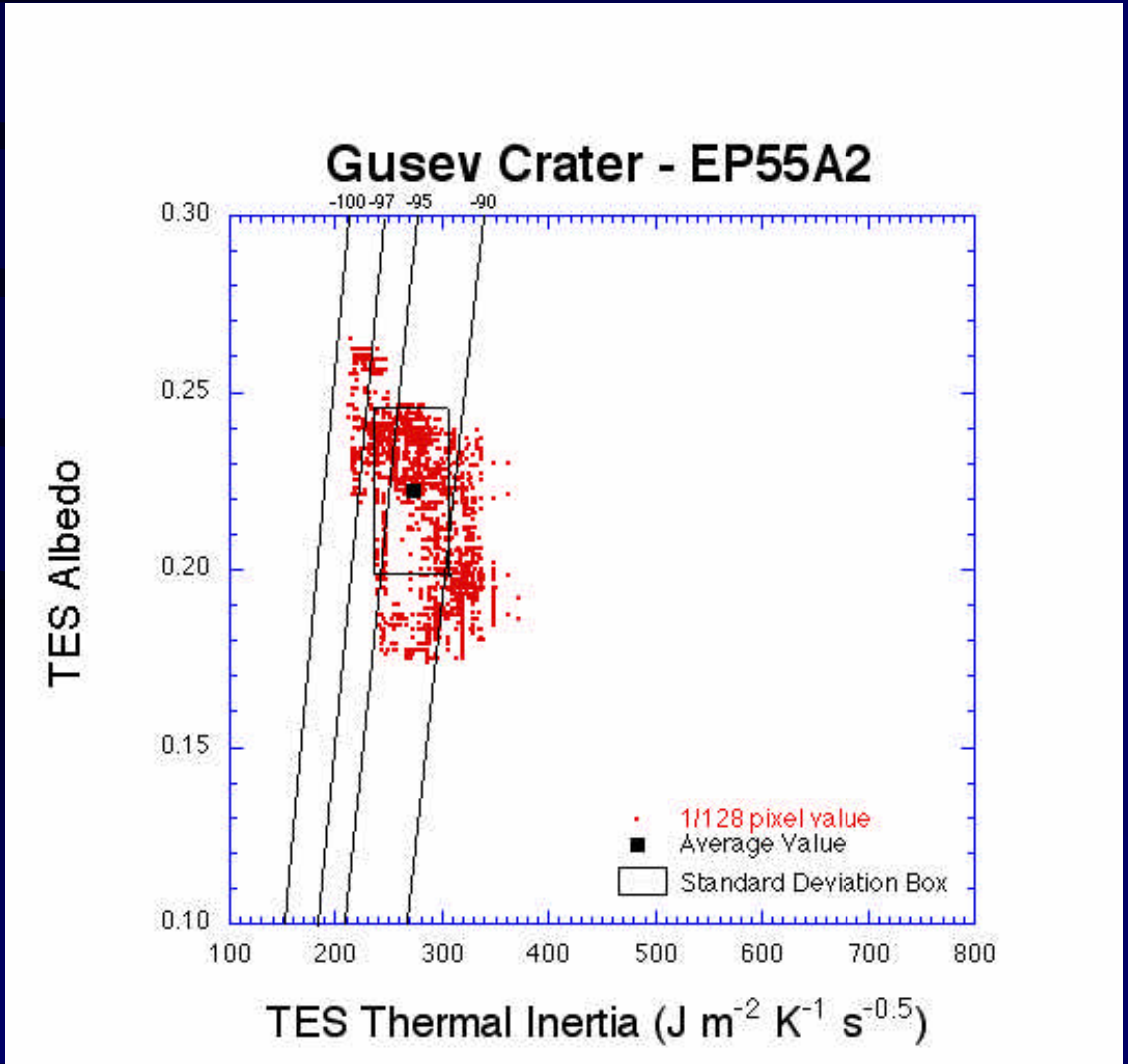
Isidis Site TES Albedos and Thermal Inertias



Isidis Site Minimum Temperatures

Probability of being < -97°C = 0%

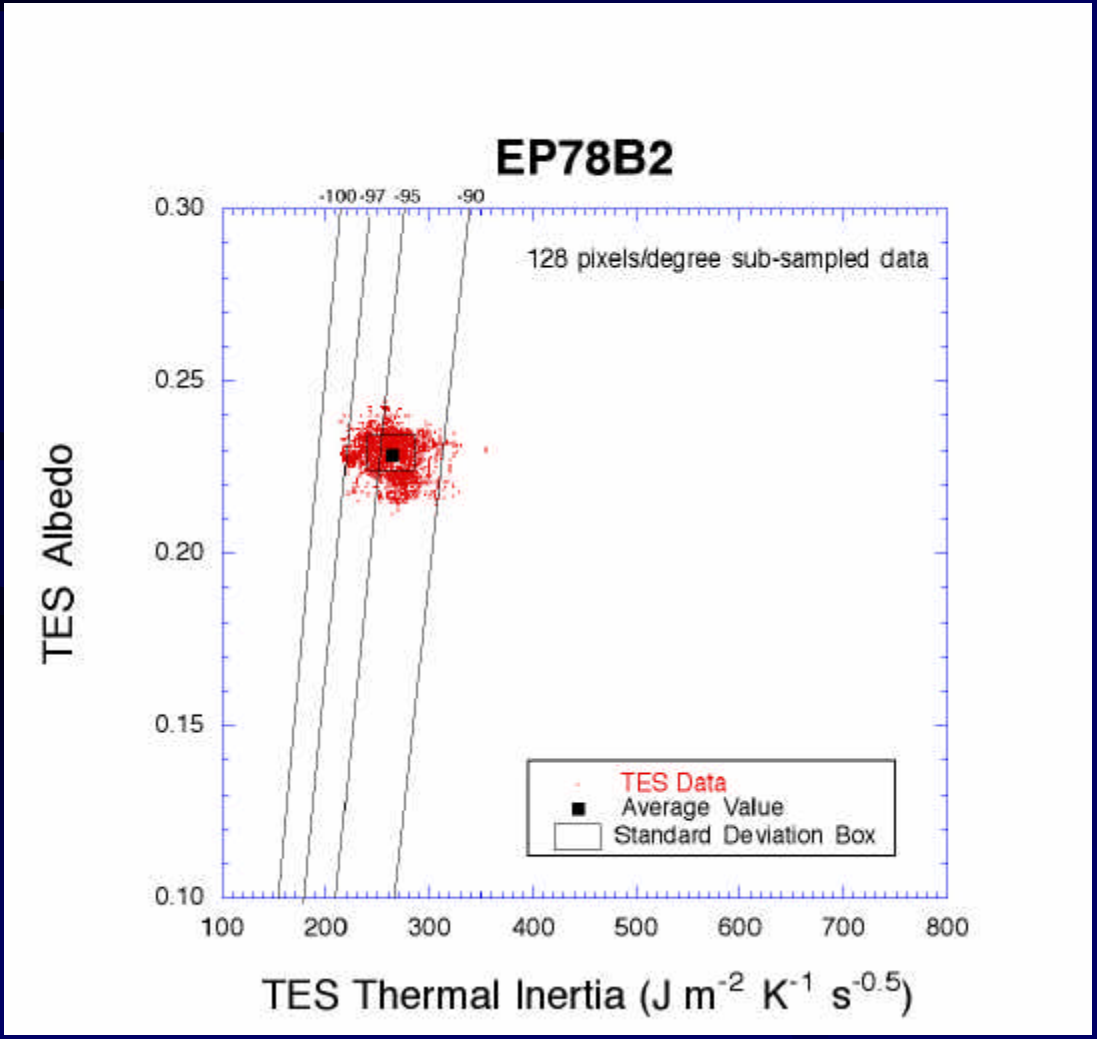
Gusev Site TES Albedos and Thermal Inertias



Gusev Site Minimum Temperatures

Probability of being < -97°C = 3%

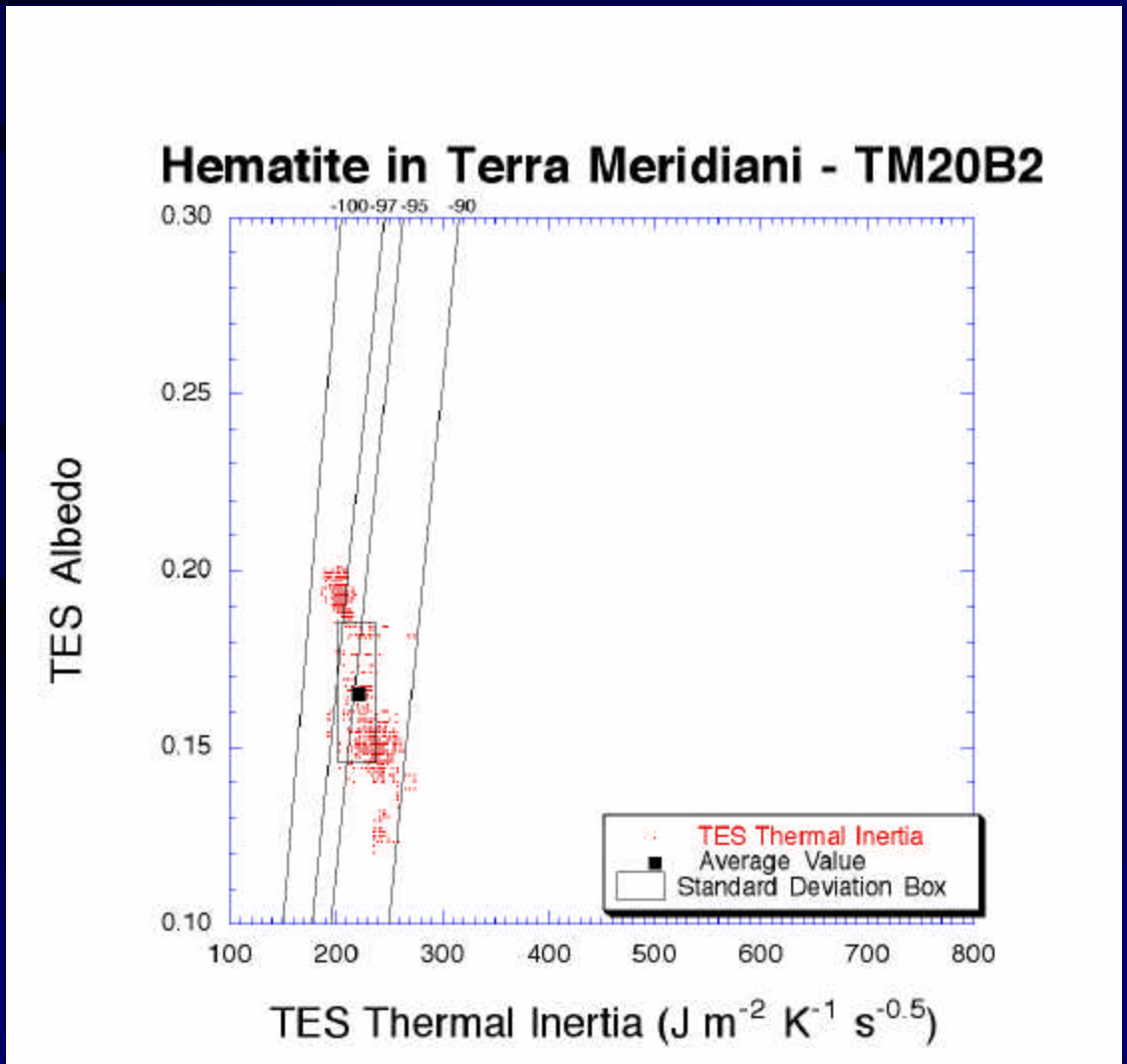
Elysium Site TES Albedos and Thermal Inertias



Elysium Site Minimum Temperatures

Probability of being < -97°C = 7%

Hematite Site TES Albedos and Thermal Inertias



Hematite Site Minimum Temperatures

Probability of being < -97°C = 8%

Thoughts

- Ponding of cold air in topographic lows under still conditions could enhance nighttime minima; airbags may roll into such lows
- Wind-induced mixing of warmer air from higher altitudes would help; mesoscale models may shed light on such nighttime winds; but Hematite shows little drainage wind
- Winds would also act to mix air from varying A/I domains, making high-resolution THEMIS data less relevant

Conclusions

- Some regions within the Hematite, Elysium, and Gusev ellipses will produce lifetime-limiting cold night temperatures, but the probability of landing in these regions is < 10%
- However, small spatial-scale thermal variation could be a factor. We are currently examining Themis nighttime IR data.
- Mesoscale model results should be explored to corroborate these findings